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CAN COMPUTERS PENETRATE THE FOG OF WAR?

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Maritime Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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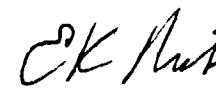

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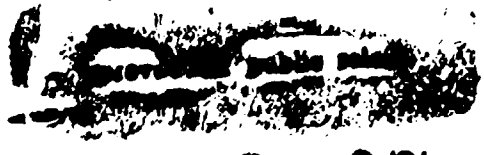

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Computerized Systems are playing an increasingly important role in our Command and Control process. These systems promise to process large quantities of battlefield data, aid in operational decision making through sophisticated display and artificial intelligence, and provide the operational commander nearly absolute control over his forces. Will these capabilities remove the ambiguity and uncertainty from the battlefield? Will they penetrate the "fog of war"? Information overload, reinforcement of human decision bias, and centralized control that undermines tactical initiative are possible drawbacks of computers in command and control. Ultimately, it will be the operational commander's understanding of the strengths and limitations of these tools and his skill in using them, that will determine his success.

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Abstract of
CAN COMPUTERS PENETRATE THE FOG OF WAR?

Computerized Systems are playing an increasingly important role in our Command and Control process. These systems promise to process large quantities of battlefield data, aid in operational decision making through sophisticated display and artificial intelligence, and provide the operational commander nearly absolute control over his forces. Will these capabilities remove the ambiguity and uncertainty from the battlefield? Will they penetrate the "fog of war"? Information overload, reinforcement of human decision bias, and centralized control that undermines tactical initiative are possible drawbacks of computers in command and control. Ultimately, it will be the operational commander's understanding of the strengths and limitations of these tools and his skill in using them, that will determine his success.

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CHAPTER I

INTRODUCTION

> The ultimate goal is simple: Give the battlefield commander access to all the information needed to win the war. And give it to him when he wants it, where he wants it, and how he wants it.[1]
>
> General Colin L. Powell

The Problem of Command

During the Battle at Jena, Napoleon viewed the battlefield from a hill above the plain. His view was limited by the visible horizon and the smoke of the battlefield below. His communications with his commanders was done using messengers. As he watched what he thought was the main the battle below, completely unknown to Napoleon, General Devaut was engaging and defeating the main Prussian force at Auerstadt.[2] In contrast, today's commanding general overseas a battlefield that extends well beyond the horizon encompassing thousands of square miles. His view of the battlefield is through computerized displays that are fed by a wide range of sensors. He has real time communications with his commanders and immediate knowledge concerning the disposition of his own forces. Yet, he has some of the very same concerns as Napoleon:

Staying informed about what is going on;

Transforming this information into meaningful decisions; and

Getting the decisions executed.[3]

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[1]GEN Colin L. Powell, "Information Warriors," *BYTE* (July 1992), p. 370.

[2]Martin van Crevald, *Command in War* (Cambridge, MA: Harvard University Press, 1985), p. 90-95.

[3]VADM Jon L. Boyes and Stephen J. Andriole, ed., *Principles of Command and Control* (Washington, DC: AFCEA International Press, 1987), p. 18

Computers as a Force Multiplier

Clausewitz tells us, "This difficulty of *accurate recognition* constitutes one of the most serious sources of friction in war, by making things appear entirely different than one had expected."[4] Computers and modern, reliable communications systems promise to make the business of command and control easier. Command, Control, Communications, Computers and Intelligence (C4I) systems may be able to eliminate some of the uncertainty associated with combat -- they may cut through the "fog of war." C4I systems can automatically gather and display large amounts of information about the battlefield and the disposition of forces. Computers can aid the commander's decision process by rapidly calculating the probable outcome of various courses of action. Orders can be transmitted to subordinates almost instantaneously, including the commander's view of the battlefield. Skillfully used, these systems can be a significant force multiplier -- information can be analyzed and decisions made and executed before the enemy has time to react. C4I systems, as a force multiplier, allow the operational commander to operate "inside the enemy's decision loop."[5]

Computerized command and control systems have the potential to significantly enhance the overall combat effectiveness of our forces. But in each step of the decision

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[4]Carl von Clausewitz, *On War* (Princeton, NJ: Princeton University Press, 1976), p. 117.

[5]There are many models for evaluating combat decision making. John Boyd models this process as "Observe-Orient-Decide-Act." The O-O-D-A loop is simple and describes the key steps to this process. This model will be used throughout this paper. Further discussion of this and other models is contained in George E. Orr, *Combat Operations C3I: Fundamentals and Interactions* (Maxwell Air Force Base, AL: Air University Press, 1983), pp. 23-43.

loop, there are hazards associated with the use of these systems. In the "Observe-Orient" process there is the potential that information overload may undermine sound decision making. The "Decide" function may be biased as a result of the information that the computerized system provides and how it is provided. The ability to "Act" with innovation and initiative may decrease as computers allow for increased centralization. Ultimately, the operational commander's success will depend on how well he exploits the advantage that computerized command and control systems can provide. He must understand the potential problems with these systems and know how to minimize their influence.

CHAPTER II

INFORMATION OVERLOAD

> Nothing is so contradictory and nonsensical as this mass of reports brought in by spies and officers sent on scouting reports. . . . To draw the truth from this mass of chaotic reports is something vouchsafed only to a superior understanding.[1]
>
> Napoleon

What is going on?

The first question that an operational commander must ask is: "What is going on?" Answering this question is really a two step process. First, data must be gathered concerning the disposition of friendly and enemy forces. Then the commander must transform this data into understandable information. These steps correspond to the "Observe and Orient" steps in John Boyd's decision loop. In a modern command system, the press of time, the vast quantity of data that must be processed, and the characteristics of computerized display systems may get in the way of an accurate information decision. The commander is overcome by "information overload." Problems exist with information collection and with using that information to obtain an accurate picture of conditions on the battlefield.

Information about the enemy may be incomplete or unreliable as a result of concealment and deception. Even information concerning our own forces is not always complete and accurate. This aspect of the problem is not unique to modern warfare. The difference today is the size of the battlefield and the pace of operations. The area of operations for the Jena campaign was hundreds of square miles and Napoleon's forces

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[1]Quoted in Martin Van Crevald, *Command in War* (Cambridge, MA: Harvard University Press, 1985) p. 68.

could cover about 50 miles in one day. The area of operations for *Desert Storm* was thousands of square miles. Troops could advance hundreds (or with aircraft even thousands) of miles per day.

An Insatiable Appetite for Information

When the scale and pace of modern warfare is combined with vast C4I resources, sophisticated communications, and the uncertainty of combat, an operational commander may feel that it is in his interests to have all information at his fingertips in real time. No system today can meet this insatiable demand for information. In *Operation Desert Storm*, limitations in the capacity of our systems resulted in backlogs and stoppages of data from the intelligence community to the operational commanders.[2] Lee Paschall, former Director of the Defense Communications Agency, suggests that an approach that attempts to deliver all data to the operational commander in real time is not only unrealistic, but is likely to lead to information overload. "When that happens he's confronted with so much information that he can't figure out which is important to decide."[3]

Some experts believe that there are limitations to the human capability to comprehend information, and that exceeding these limitations will lead to information overload and concomitant poor decision making. Although there are different ways to measure comprehension, this analogy is understandable:

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[2]Michael R. Macedonia, "Information Technology in Desert Storm, *Military Review* (October 1992), p. 39

[3]Quoted in Thomas P. Coakley, *Issues of Command and Control* (Washington, DC: National Defense University Press, 1991), p. 286.

> "To give a feeling for human comprehension capability some researchers claim that a human being can comprehend written text at a data rate (in computer data rate terms) of only about 1,000 bits/minute. Applied to a page of text of about 250 words or 14,000 bits, a human being would require about 14 minutes to comprehend the information on that page. Even if comprehension rate were five times greater for a trained reader familiar with the subject, understanding of the content would require about three minutes."[4]

Discussing Navy plans for a Radio-Electronic Battle Management System (REBM), retired Admirals Jon Boyes and Henry Mustin expressed concern that the ability of the operators to absorb information and still make sound decisions would limit the usefulness of an REBM system. Admiral Mustin says, "Because the problem is not solely one of processing and software but one of the human's ability to deal with the information, no technical solution has been provided to manage the data in a timely way to respond."[5]

The concerns of Admiral Boyes and Admiral Mustin were illustrated on board the *USS Vincennes* when a commercial airliner was shot down by mistake.[6] In his analysis of this incident, William Gruner points out that investigators concluded that "The Aegis combat system's performance was excellent -- it functioned as designed." He concludes that the problem is with the humans operating the system not with the machines: "Simply put, the rate at which the brain can comprehend information is too slow under fast-paced action. It has neither the time to understand all the inputs it receives, nor the ability to

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[4]William P. Gruner, "No Time For Decision Making," *U.S. Naval Institute Proceedings*, November 1990, p. 40.

[5]John F. Morton, "Can We Manage the Radio-electronic Battle?" *U.S. Naval Institute Proceedings*, (January 1991), pp. 92-93.

[6]On July 3, 1988 the *USS Vincennes* mistakenly classified an Iranian Airbus as a hostile F-14 fighter. The Airbus was shot down with missiles from the Vincennes, killing 290 civilians.

effectively perform all the other function it would be capable of in a less harried environment."[7]

In *Desert Storm*, the Air Tasking Order (ATO) illustrated the problem of information overload. This computerized listing of all coalition air operations resulted in a thousand page document each day. With limited time available to read and comprehend this data, tactical air planning staffs concentrated on the information that specifically pertained to them. They were "often unaware of other missions in the same area that might have affected their plans even though that information was buried in the ATO."[8]

Data Fusion

One technique for reducing the information that an individual commander must digest is to use decentralized fusion of information sources. In this way the commander sees only relevant information with duplication removed. Lincoln Faurer, former Director of the National Security Agency, argues that the operational commander is best served by "finished intelligence" according to needs identified by the commander. On the other hand, if the operational commander tries to satisfy "an insatiable appetite for information . . . this list would become so long, it would not be possible to provide a commander with that amount of intelligence." Communications channels would be overloaded.[9]

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[7]Gruner, p. 40.

[8]Michael R. Macedonia, "Information Technology in *Desert Storm*, *Military Review* (October 1992), p. 38.

[9]Lincoln Faurer, 'The Role of Intelligence in C3I," in Coakley, p. 329-332.

The processing of intelligence information preceding and during *Operation Just Cause* (the 1989 invasion of Panama and capture of General Manuel Noriega) supports General Faurer's judgment. In October, 1989 the Bush administration wanted to support the rebels in an attempted coup directed against General Noriega.[10] Conflicting and ambiguous information concerning the rebel leadership and uncertainty whether General Noriega had been captured frustrated the administration.[11] Mr. Bush's desire to receive reports directly from the American Embassy, Central Intelligence Agency and the United States military in Panama left him trying to sort out conflicts in information that should have been resolved at a lower level."[12]

In order to validate information provided through data fusion, the operational commander can use a tool that Martin van Crevald refers to as a "directed telescope."[13] Using a "directed telescope," the commander can obtain specific informaton from sources that have not gone through the fusion process. The normal reporting system should provide the commander with most of the information that he needs, a directed telescope would allow him to confirm various aspects of this information by cutting out the filtering

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[10]During the attempted coup, the administration wanted to come to the aid of the rebels. Reports from available intelligence sources were not consistent. Unable to sort out the conflicting information in a timely way, the administration did not take action to assist the rebels.

[11]William S. Ramshaw, "Operation JUST CAUSE Command and Control: A Case Study," Unpublished Research Paper, Naval Postgraduate School, Monterey, CA: 1991, p. 31-33.

[12]Andrew Rosenthal, "White House Seeks Closer Contacts in a Panama Coup," *New York Times*, 13 October 1989, p. A-8.

[13]Van Crevald, p. 75.

and refinement of the fusion process. Similarly, the commander should be able to "pull down" information in addition to data "pushed" to him by the fusion center.

Optimizing information management in modern C4I systems requires the operational commander to determine what information he wants provided by the standard reporting system and what details should be available upon demand. Key information may not meaningful until it is seen juxtaposed other information. Operational planning must include determining information needs such that operational decision making can be optimized. If these choices are correctly made, the combination of fuzed data and information available upon request can offset some of the problem of information overload. This concern is being pursued by Navy technical laboratories and war gaming centers.[14] Additionally, the "C4I for the Warrior" concept provides a roadmap for future C4I system development. This approach includes both integrated data fusion and "warrior pull on demand."[15]

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[14]Interviews with the staff of the Naval Undersea Warfare Center, Newport, Rhode Island, the Wargaming Department at the Naval War College, Newport, Rhode Island, and the Wargaming Department at National Defense University all affirmed their efforts in this area. The next generation command and control system, *Copernicus*, will include enhanced data fusion capability.

[15]Joint Staff brochure "C4I for the Warrior" 12 June 1993.

CHAPTER III

OPERATIONAL DECISIONS

> Command logic is more subtle than machine logic; it is not "if A do Z," but rather "if A then assume P or Q for the time being and do X to temporize." The genius of combat decision making is knowing when (neither too early nor too late) to commit: when to take step Z.[1]
>
> Captain Wayne Hughes
> Professor of Operations Research
> Naval Post Graduate School

The Command Decision Process

After a commander has decided that he knows "what is going on" adequately to make decisions, he must then take the next step in Boyd's decision loop: Decide. Modern warfare forces the commander to make decisions at a high tempo under conditions of great uncertainty. Flag-level decision makers may be forced to make high risk decisions under deadlines that do not allow careful evaluation of alternatives. During one war game conducted at the Naval War College in Newport, Rhode Island a flag officer made 10 separate decisions in the first 58 minutes. Eight of these decisions were made in four minutes or less.[2]

C4I systems may aid the decision maker by presenting information in an easily understandable manner. Automated decision aids or decision support systems can quickly

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[1]Quoted in James G. March and Roger Weisinger-Baylon, ed. *Ambiguity and Command: Organizational Perspective on Military Decision Making* (Marshfield, MA: Pitman Publishing, 1986) p. 252.

[2]Roger Weissinger-Baylon in March and Weissinger-Baylon, *Ambiguity and Command* p. 44-45.

calculate probabilities associated with a range of choices by projecting the results of choices into the future. On the other hand, focussing on a computer terminal during high tempo operations may also remove the decision maker from the real world and his combat forces. Decisions may be made based solely on the computer representation of events even if external information indicates the computer picture is flawed. Finally, characteristics and limitations of human information processing predispose the final decision.

Human Decision Making

Psychological testing shows that operational commanders enter the decision process with a pattern of thinking (called heuristic thought) that influences the final decision:[3]

1. They tend to believe the actual situation is accurately represented by and can be projected from known information. But this is only true if the events are deterministic. If chance plays a significant roll, the available information may substantially misrepresent future outcomes.

2. Decision makers rely on their past experience to estimate the probability of possible outcomes. Unfortunately, the commanders experience may not be large or representative of the situation he is facing. Additionally, experience that is easily recalled gets disproportionately higher weight.

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[3]George E. Orr, *Combat Operations C3I: Fundamentals and Interactions* (Maxwell Air Base, AL: Air University Press, 1983) p. 72-73 and Brian C. Nickerson and Dario E. Teicher, "Factors That Affect Shipboard Decision Making." Unpublished Research Paper, Naval Postgraduate School, Monterey, CA, p. 90-91.

3. Military commanders tend to overestimate their ability to develop subjective estimates of likely outcomes. Since they are selected to their current position based upon past success, this is not surprising.

4. Once an estimate is made, decision makers are reluctant to revise that estimate without substantial additional information.

Computers can reinforce some of these decision tendencies. A picture of the battlefield is displayed clearly on the computer screen. This information is readily available to the commander. Although there may be other information sources that can be used to augment this picture, the commander must request these separately. Finally, the computer display gives an impression of completeness and correctness. The ambiguity of displayed information is often not evident. "The danger in relying too heavily on displays, particularly digital displays, is that they may not reflect the degree of uncertainty that surrounds, the position, composition, identity or even the existence of the targets displayed."[4] Once the commander has made a decision (even if based upon flawed information), he is disinclined to change.

The *Vincennes* incident illustrates this problem. There were several sources of information available to the crew of the *Vincennes* that could have confirmed or disputed their classification of the incoming aircraft as hostile: the *USS Sides* was operating 18 miles away and held the same aircraft on her radar as ascending, not descending; the *Vincennes* was equipped with commercial radios that would have allowed her to contact

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[4]Frank M. Snyder, *Command and Control, the Literature and Commentaries* (Washington, DC: National Defense University Press, 1993), p. 109.

the tower at Bandar Abbas airport; a report that the track might correlate to a commercial airliner was waived aside; and the lack of hostile emissions from the suspect aircraft was not pursued.[5]

Reliance on past and easily recalled experiences and the reluctance to change a decision without overwhelming evidence to the contrary were also illustrated on board the *Vincennes*. The Anti-Air Warfare Officer incorrectly correlated the IFF signal from an F-14 on the ground at Bandar Abbas with the airbus. Tragically, this mistake substantially affected his and the commanding officer's interpretation of subsequent events.[6] Additionally, the CO of the *Vincennes* "may have perceived that the scenario unfolding was identical to an incident experienced by the *USS Wainwright* three months earlier."[7]

Computerized Decision Making

Computerized decision support systems can help overcome these biases, but they will not always produce the "correct" answer. Computers can counter the human difficulty with stochastic processes by rapidly calculating and displaying a wide range of probable outcomes. Computers may offset a failure to include new information after an initial decision is made. By displaying the relationship of a given decision relative to predicted outcomes using available data, the variance of an early decision will become evident sooner.[8] The computer gives the commander rapid feedback concerning the

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[5]Nickerson and Teicher, p. 12, 86.

[6]*Ibid.*, p. 62.

[7]*Ibid*, p. 12.

[8]Orr, p.

implication of new information. Still, there are distinct limitations to computerized decision aids.

One limitation is in the design of the decision aids. There are two different approaches to the design of these systems: calculation of variables and decision modeling. The former is a spreadsheet based system in which inputs are weighted to produce a calculated outcome. The advantage of this kind of system is that it is relatively inexpensive, easy for the operator to understand how the computer derives a result and can be applied to a range of situations. The disadvantage is that the accuracy of the outcome is dependent upon the accuracy of the weights assigned and the formula used.

The other type of decision aid, a decision modeling system, attempts to duplicate the command decision process, perhaps including artificial intelligence so that the computer can "learn" as it responds to new and different situations. The biggest problems with this strategy are the high cost and the limited applicability of a given decision making model across the spectrum of decisions faced by a military commander.[9] Another drawback is that it is much more difficult to understand how the computer derives its answer. Models of combat decision making have not yet been perfected, and "commanders are likely to rely on decision aids only to the extent they are persuaded of the strengths yet understand the weaknesses of this modern electronic analyst."[10]

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[9]Caral A. Giammo, "Computer Based Decision Support Systems For Command and Control," Unpublished Research Paper, The Industrial College of the Armed Forces, Fort McNair, DC: 1988, pp. 7-11.

[10]Snyder, p. 63.

Computers are not infallible. Robin A. Dillard, a Naval Ocean Systems mathematician evaluated the *Vincennes* incident using four different decision models. When the models were provided the same information that was used by shipboard decision makers (including the erroneous report of decreasing altitude), all four models came to the same conclusion as the crew of the *Vincennes*. When the problem was evaluated with the correct altitude data, three of the four models still provided the most likely classification of the airbus as a military aircraft and two of the four listed "hostile military" high on the list of probable classifications.[11] In other words, even without any human bias concerning the surrounding combat or other recent events in the Gulf, a computerized decision aid would not necessarily have averted this tragedy. Decision makers in *Desert Storm* were aided by a decision support system called HAWKEYE. But this system depended on a set of rules and templates to produce appropriate results. Saddam Hussein did not follow these rules; his behavior often seemed irrational. Certainly, he did not fit the computer model. [12]

The final limitation to the use of computers in combat decision making reflects the nature of the decision itself. The decision is predictive and must account for the role of chance and morale in assessing the likelihood of success. Combat is not a game of chess. Captain Hughes suggests:

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[11]Robin A. Dillard, "Using Data Quality Measures in Decision-Making Algorithms," *IEEE Expert*. (December 1992), p. 66-68.

[12]Michael R. Macedonia, "Information Technology In *Desert Storm*," *Military Review*, October 1992, p. 39.

> If one were making decisions at chess the way a commander must make battle decisions, then each player would make his move the turn before it was executed. White would write "P-K4" on a piece of paper, Black would write down his move, and only then, while White was writing his second move, would White be allowed to advance his pawn to king-four. The game would be entirely different, full of subtlety and traps.[13]

Even this example lacks the element of chance. Perhaps Backgammon (played in a similar way) would be closer.[14] But the morale influence of surprise, shock and fear are still missing. The power of effective leadership to overcome these factors is not included.

In the end, the operational commander cannot depend upon computers to do his job for him. He can use computers to improve his decision making if he understands the shortcomings in his own human decision process and the limitations of the computers. This understanding comes in part from familiarity. If they are to fully exploit the potential of modern C4I systms, operational commanders must find opportunity to train with the systems that they will actually use in combat during a variety of scenarios. Finally, acting to slow down the decision process so that information can be analyzed before reacting rather than trying to keep pace with the computer, may be the best course of action in some circumstances.

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[13]March and Weissinger-Baylon, p. 253.

[14]Orr, p. 55.

CHAPTER IV

EXECUTION

> If subordinates are deprived -- as they now are -- of that training and experience which will enable them to act "on their own" -- if they do not know, by constant practice, how to exercise "initiative of the subordinate" -- if they are reluctant (afraid) to act because they are accustomed to detailed orders and instructions -- if they are not habituated to think, to judge, to decide and to act for themselves in their several echelons of command -- we shall be in sorry case when the time of "active operations" arrives.[1]
>
> Admiral E. J. King (21 January 1941)

War from the Green Screen

After an operational Commander has made a decision, he must direct his forces to execute that course of action and monitor their progress. C4I systems can aid in this aspect of command and control by providing a quick, convenient method of relaying orders and by allowing close track of the battle. At the same time, C4I systems have two potential pitfalls. First is a temptation to run the war from the computer display, risking loss of touch with the actual battlefield and the role of leadership and morale. The second problem is that while computers and real time communications systems allow an operational commander to maintain tight control over his forces, this practice may undermine the initiative of the tactical commanders.

Over one hundred years ago, General Helmut von Moltke warned, "War cannot be run from a green table."[2] (If he were alive today, Moltke might have used the phrase

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[1]Julius A. Furer, *Administration of the Navy Department in World War II.* (Washington, 1959), Naval War College reprint, p. 943.

[2]Gen. Crosbie E. Saint, "Commanders Still Must Go See," *Army*, June 1991, p. 20.

"green screen" instead.) If the operational commander puts too much emphasis on the battlefield picture that is displayed by the computer, he may neglect the moral aspect of war. War cannot be fought as a video game. Clausewitz's observation: "The moral elements are among the most important in war"[3] is valid today, even with the introduction of computers. Fighting the war from the command center may diminish the leadership from the operational commander that is essential to a successful campaign.

During *Desert Storm*, the scope and pace of the operation influenced the command staffs to emphasize the technical aspects of the war rather than the "clash of moral forces." One example of this is the predominance of Battle Damage Assessment based upon imagery alone:

> The allure of pictures stems from the fact that they are a more concrete form of data than the products from other intelligence collection methods such as enemy prisoner of war debriefs. Those products are complex and require sophisticate analysis. However, Horner has stated that "we may have been overly entranced with some forms of intelligence collection" (imagery to the detriment of other sources of information) which indicated that the Iraqis were far more dissipated than BDA indicated. Pictures are critical to determining the disposition of enemy forces, but they do not reveal the state of the enemy mind or morale.[4]

Over-reliance on the computer may not only remove the commander from the battlefield, but it may also remove him from his troops. They may be deprived of his leadership. Computers and sophisticated communications systems must not remove the element of leadership from command. General Crosbie E. Saint warns, " Personal

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[3]Carl von Clausewitz, *On War* (Princeton, NJ: Princeton University Press, 1976) p. 184.

[4]Michael R. Macedonia, "Information Technology in *Desert Storm*," *Military Review*, October 1992 p. 38.

interface is a crucial element in dispelling the fog of war. It enhances the operational commander's ability to feel the pulse of the battle."[5] During *Operation Urgent Fury*, the invasion of Grenada, Admiral Metcalf had the technical capability to conduct the entire operation from his flagship using voice radio and message traffic. But he wanted to be sure that his intentions were clearly understood by his subordinate commanders. He held daily face-to-face discussions with his subordinate commanders. He also used a common communications circuit to talk to Admiral McDonald, his amphibious task force commander. "[This] particular party line came to serve very useful purpose. It conveyed our intentions to those commanders without having to go over them again individually with each ship captain."[6]

A similar situation existed during *Desert Shield*. From his headquarters in Florida, General Schwartzkopf was able to communicate with unit commanders in the Persian Gulf while simultaneously talking to General Powell in Washington. Yet he knew that the best place for his headquarters was in the Saudi Arabian desert. From there, he was in a better position to exert his personal leadership to influence his subordinate commanders and the other members of the coalition.[7]

The Commander's Intent

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[5]Crosbie E. Saint, "Commanders Still Must Go See," *Army* (June 1991), p. 22-23.

[6]James G. March and Roger Weissenger-Baylon, *Ambiguity and Command: Organizational Perspectives on Military Decision Making* (Marshfield, MA: Pitman Publishing, 1986) p. 292-294.

[7]Richard H. Buenneke, Jr., "Lifting the Fog of War," *Government Executive*, (February, 1991), p. 20.

Computers and extensive real-time communications may tempt commanders to make incremental decisions that involve the minimum necessary commitment. C4I systems may subvert the usual planning process in which the commander develops a concept of operations for an operation, then communicates his intentions along with various contingencies to his subordinates.[8]

The performance of the Israeli army command during the 1973 war with Egypt illustrates this problem. During the initial Egyptian attack, the Israeli Defense Force (IDF) never developed an overall concept of operations. Tactical details of the operation were controlled by the IDF Chief of Staff from his headquarters in Tel Aviv. Operational commanders positioned themselves to maximize communications with their superiors rather than to optimize control of their subordinate forces. The result was the worst defeat ever experienced by the IDF. Although computers were not part of the problem, and communications were not as sophisticated as those available today; it was technology that allowed such a high degree of centralized control. The addition of computers and improved communications equipment make this level of control even more possible today. Centralized control compels each individual commander to put a premium on maintaining communications with his immediate superior. Even the threat of centralized control prompted Admiral Metcalf to devote one-third of his staff to keeping the boss informed.[9]

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[8]Frank M. Snyder, *Command and Control: The Literature and Commentaries* (Washington, DC: National Defense University Press, 1993), p. 61.

[9]March and Weissinger-Baylon, p. 284.

Another risk of depending upon centralized control is the vulnerability of communications systems during war. The early destruction of Saddam Hussein's command and control machinery provided the coalition forces a significant advantage during Desert Storm. Conversely, our own "space based communications were vulnerable to jamming had the enemy chosen to do so."[10] Without a clearly communicated concept of operations, loss of communications connectivity may result in operational paralysis.

In order to assure that their forces are able to act with innovation and initiative, operational commanders must take the time to develop a concept of operations and clearly communicate it to their subordinates. Discussions should be done face-to-face when possible. And at the same time subordinates must recognize their responsibility to operate within the bounds of the commander's intent and to "keep the boss informed."

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[10]*Conduct of the Persian Gulf War: An Interim Report to Congress*, July 1991, p. 15-2.

CHAPTER V

SUMMARY, RECOMMENDATIONS and CONCLUSION

> You have to be a little careful about what you say you learned from Desert Storm. But one lesson I am utterly confident we've learned is that we have become dependent upon information technology. It is now and will continue to be a very significant portion of our military force.[1]
>
> LT GEN Robert H. Ludwig
> Air Force DCOS for C4

Summary

C4I systems will be a force multiplier for the operational commander if skillfully employed. In order to exploit this technology, the commander must also recognize its inherent limitations. The problems of information overload, faulty decision making, and degraded coordination of combat operations must be addressed in the design and the use of these systems. The operational commander must possess more than just superficial knowledge of these systems along with their liabilities. Just as the key questions of operational command have not changed since the days of Napoleon, neither has the demand that the commander develop an instinctive knowledge of his art and his tools. Clausewitz observed: "Knowledge must be so absorbed into the mind that it almost ceases to exist in a separate, objective way."[2]

Flag and general officers are aware of many of the potential hazards with increasing dependence on computerized command and control.[3] Recent operational

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[1]Quoted in Macedonia, p. 41 (from *Government Computer News*, 5 Aug 91)

[2]Carl von Clausewitz, *On War* (Princeton, NJ: Princeton University Press, 1976), p. 147.

[3]Over half of the references listed in the bibliography for this paper were written by flag or senior military officers highlighting concern for these issues.

experience validates their concern. Yet appreciation of these problems does not mean that he will be able to compensate for them in his decision process. The short time and high risk associated with the choices will make adjustment of the human decision process difficult under the stress of combat. Additionally, the proliferation of computer technology may mean that many of the advantages we enjoyed during the Gulf War may be available to a future adversary. In the future, our advantage might be the skill with which we use this technology.

Recommendations

The following considerations should be part of future operations and training aimed at improving our C4I capability:

1. Identification of information needs must be part of operational planning such that the operational commander gets the information he wants, and to the extent possible in the form that he wants it. This should include not just the highest level of fused information, but one or two levels of "pulled down" information. Additionally, the reporting and processing should be flexible enough to allow an operational commander to tailor each level to his operational style. The operational commander can not let these choices be left to the computer programmer.

2. Training events must include some amount of ambiguous information so that commanders do not come to expect certainty from computer displayed data. In addition, combat leaders cannot become so dependent upon computers that they are unable to fight if these systems become degraded. War games and major fleet exercises need to include system degradation due to jamming or battle damage.

3. The operational commander must be familiar with the limitations of his own decision style and the role of computers in the decision process. His effectiveness will depend, in part, on his familiarity with the specific system he will use in combat. Thus it is imperative that he be as familiar with the command level displays and decision aids as his tactical commanders are with their weapon control systems. This can only occur if commanders exercise their decision strategies in a wide variety of scenarios using the displays and decision aids they will actually use in combat. War games alone will not develop this familiarity.

4. Commanders must avoid the temptation to fight the war "from the green screen." The C4I system gives the today's commander the best view of the battlefield. It is modern equivalent to Napoleon's hilltop command post. But, commanders must ensure that they stay in touch with their forces and the moral aspects of combat. They interact with their subordinates face-to-face when possible.

5. Finally, the operational commander must know when to slow things down. Although one goal of computerized command and control is to "get inside of the enemy's O-O-D-A loop," the desire should not overshadow the demand for rational decision making.

Conclusion

C4I systems have potential to be a great force multiplier. Fully exploiting this potential is the resposibility of the operational commander. These systems can not completely eliminate the fog of war. They will not do the commander's job for him. He must still determine what information he needs, and evaluate available information for

completeness, accuracy and relevance. While constrained by time, he must make difficult decisions with incomplete information. And he must direct his forces in battle. C4I systems can aggravate the problems with information overload, heuristic decision making and optimal control of forces; or they can mitigate them. The commander's success will depend upon his own skill in using these tools.

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